REMARKS:

This application has been carefully studied and amended in view of the Office Action dated December 8, 2009. Reconsideration of that action is requested in view of the following.

In order to advance the prosecution of this case Claim 1 has been amended to refer to the solution viscosity of the polyamides using the precise language set forth at page 2, lines 24-26 of the Specification. Accordingly, there should be no question that the terminology used in Claim 1 does not involve new matter. As such, the objection to the Specification in paragraph 3 of the Office Action and the rejection of the claims under 35 USC 112 as regards "polyamide" should now be moot.

Reconsideration is respectfully requested of the rejection of the claims under 35 USC 112 with regard to use of the phrase "solution viscosity" not being adequately described in the Specification. It appears that Examiner Aughenbaugh is basing the rejection on his conclusion that the phrase "solution viscosity" is dimensionless because US 5,728,104, US 70,049,391 and US 7,491,792 each disclose a "relative solution viscosity" which is dimensionless. Examiner Aughenbaugh should recognize that there is a difference between "solution viscosity" and "relative solution viscosity" and that the "solution viscosity" must not be dimensionless. The term "solution viscosity" is a common used term which is used for the viscosity of a polymer which is solved in a solvent, the "relative solution viscosity" which is the solution viscosity divided by the viscosity of the solvent and for the "viscosity number" which is the relative solution viscosity divided by the concentration of the polymer in the solution.

At first, the solution viscosity is the viscosity of a polymer in a solvent. The unit of this solution viscosity is Pa·s. The relative viscosity or relative solution viscosity is the viscosity of the polymer in the solution having the unit Pa·s divided by the viscosity of the solvent also having the unit Pa·s. Therefore, the relative viscosity or relative solution viscosity is dimensionless. In this context the word "relative" is important since this word points out that a ratio of two numbers with equal units is meant wherein one of the numbers is divided by the other such that the result is dimensionless.

Finally, in common usage the term "solution viscosity" is also used for the reduced viscosity of viscosity number. The reduced viscosity or viscosity number has the unit of "ml/g" and is calculated by dividing the relative solution viscosity by the concentration of the polymer solution. Due to dividing the relative viscosity by the concentration the unit of the viscosity number or reduced viscosity is ml/g.

In a strict physical sense only the viscosity of the polymer in the solution having the unit Pa·s is a solution viscosity. The ratio of two viscosities referred to as relative solution viscosity as well as the reduced viscosity or viscosity number are strictly spoken no viscosities. However, as already mentioned above the relative solution viscosity as well as the reduced viscosity or viscosity number are referred to as "solution viscosity" in common usage.

Therefore, a person of ordinary skill in the art who sees the unit ml/g in connection with the solution viscosity knows which of the viscosities, in this case the reduced viscosity, is meant.

That the term "solution viscosity" also is used for the viscosity number (ISO 307) is for example disclosed in the attached portion of "Encyclopaedia of Polymer Science and Technology", Vol. 3, polyamides, plastics, page 639, John Wiley and Sons, Inc.

The relation between relative viscosity and reduced viscosity is also described in "Encyclopaedia of Polymer Science and Technology", Vol. 11, Rheological Measurements, page 482, 483 (attached), John Wiley and Sons, Inc.

Finally, Underwriters Laboratories describes on their homepage under the keyword "solution viscosity" the determination of a viscosity number of thermoplastics. A printout of the internet page is attached.

As evidenced by the above, it should be clear to a skilled person, that the "solution viscosity" can have a dimension and further it is clear to a skilled person, which number is meant using the term "solution viscosity" if the dimension is ml/g.

It is further submitted that Claims 1-4 and 6 are patentable over Campbell US 6,228,912 as evidenced by Christ US 5,567,797 and that Claim 5 is patentable over Campbell as evidence by Christ and in view of Nishihara US 6,790,887.

As pointed out in the prior amendment the '912 patent discloses the casing for an electronic device which is suitable for the use as a monitor housing. The casing comprises a heat-resistant, flame-retardant thermoplastic, wherein the thermoplastic material may have a polyamide-based structure. However, '912 does not disclose that a mixture of at least two polyamides with different solution viscosity is used. Further, it is not disclosed that the solution viscosity of the polyamide used is less than 140 ml/g, measured to ISO 307 in a sulfuric acid solution comprising: 0.005 g/ml of specimen.

The '797 patent discloses a mixture of polyamide 6 and polyamide 6,6 wherein the relative solution viscosity in sulfuric acid is 1.79 or 1.78, respectively. However, a relative solution viscosity of 1.79 or 1.78, respectively, as disclosed in '797 corresponds to a solution viscosity of 158 ml/g if the concentration is 0.005 g/ml as disclosed in the examples of '797. The solution viscosity therefore is greater than 140ml/g and not less than 140 ml /g as claimed in Claim 1.

Since neither the '912 patent nor the '797 patent discloses a solution viscosity of the mixture of polyamides which is less than 140 ml/g, the features of present Claim 1 are novel.

It is clear that Claim 1 is also not obvious from the prior art. The '912 patent discloses that an improvement in melt flow can be achieved when one molecular weight grade of at least one resinous constituent. However, it is not disclosed that a mixture of at least two polyamides with different solution viscosity is used. Further, there is no hint given in the '912 patent that the

solution viscosity is less than 140 ml/g measured to ISO 307 in a sulfuric acid solution comprising 0.005 g/ml of specimen.

Since it is only disclosed in the '912 patent that at least one resinous constituent having a first molecular weight grade is combined with a similar resinous constituent having a lower molecular weight grade to achieve an improvement in melt flow but there is no hint given in which way the components shall be mixed, it is not obvious to a skilled person, that satisfying properties of the polymer will be achieved when the solution viscosity of the polymer is less than 140 ml/g, measured to ISO 307 in sulfuric acid solution comprising 0.005 g/ml of specimen.
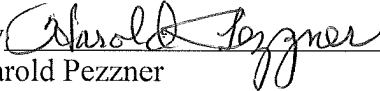
Since the solution viscosity of the polyamide is disclosed in the '797 patent is bigger than the solution viscosity as claimed in Claim 1, the skilled person does not achieve the subject matter of present Claim 1 by the '912 patent in view of the '797 patent. Therefore, the subject matter of present Claim 1 is based on an inventive step.

The '887 patent was added to the combination of the '912 and '797 patents in the rejection of dependent Claim 5. The '887 patent, however, does not overcome the deficiencies of the '912 and '797 patents which were used in the rejection of parent Claim 1. Accordingly, Claim 5 should also be allowable because of the features added to that claim as well as its dependency on Claim 4, which in turn is dependent on Claim 1.

In view of the above remarks and amendments this application should be passed to issue.

Dated: March 8, 2010   Respectfully submitted,

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POLYAMIDES, PLASTICS

Introduction

The use of polyamides in plastic applications dates back to the original commercialization of this polymer. The first polyamide application was the introduction by DuPont in 1938 of nylon-6,6 for tooth brush filaments (1). Although fiber applications soon dominated, the use of polyamides as plastics grew steadily from the 1950s and is estimated to represent more than 25% of total polyamide use in the year 2000 or 1.65 million metric tons per year (2). Growth is about 8–9% per annum compared to less than 1.5% for fibers (3).

Polyamides were the first engineering plastics and still represent by far the biggest and most important class of these types of material. The combination of mechanical and thermal properties allows them to be employed for highly specified end uses and often for metal replacement applications (see Engineering Thermoplastics, Survey).

Polyamides comprise a range of materials, depending on the monomers employed. Nylon-6,6 [32131-17-2] and nylon-6 [25038-54-4] continue to be the most popular types, still accounting for more than 90% of nylon use. Table 1 gives a summary of the properties of the more common types which are currently commercially available. In recent years there has been increasing interest in polyamides with higher melting points to extend the boundaries of this polymer type to satisfy more stringent high temperature automotive and electronic applications. This has resulted in the development of nylon-4,6 and several semiaromatic nylons.

(41) and a demonstration plant to recycle nylon-6,6 (as well as mixtures with nylon-6) was due to be commissioned in 2001 (42). The final development of recycling will probably involve a balance of part reuse, energy recovery, mechanical recycling, and chemical recycling.

Economic Aspects

The principal worldwide manufacturers of nylon resins are given in Table 7. Total sales of nylon plastics in the United States and Canada in 1998 were 495,000 t (3). West European sales were 572,000 t and sales in Asia Pacific (including Japan) were 335,000 t (3). Table 8 shows the variation of price across different polyamide types. Current estimates of growth for polyamide plastics are 9% p.a. for nylon-6 and 8.2% for nylon-6,6 (3). With fiber growth at 1.3% and 1.4% respectively, this represents a greater than 6 times higher growth rate for plastics. Published literature values for polyamide prices had remained stable through the second half of the 1990s (44) but in Europe at least, real prices had been dropping to the point at which major suppliers had needed to announce price increases in late 1999 and 2000 in order to get back to reinvestment economics (particularly in view of major oil and raw material cost increases).

Specifications, Standards, and Quality Control

Raw material specifications may be agreed between the supplier and the molder or end user, or they may be defined as requirements by an external body. The standards ASTM D4066 (45) and ISO 1874-1/2 identify how to classify and specify nylon materials and give details of tests and test methods that may be used, as well as required values. ASTM D5336 for polyphthalamides is also used. The tests include mechanical, thermal, electrical, and flammability properties as appropriate. In addition to these, it is normally necessary to specify the viscosity of the material, maximum moisture content, and ash content (if reinforced). Viscosity is generally measured as solution viscosity that corresponds directly to molecular weight, rather than melt viscosity, which is moisture-dependent. In the United States, solution viscosity is generally measured as relative viscosity (ASTM D789) or inherent viscosity (ASTM D2857), normally in 90% formic acid or m-cresol solvent. Elsewhere, viscosity measurements mainly use the internationally agreed viscosity number (ISO 307) in formic acid, sulfuric acid, or m-cresol. Moisture content is determined according to ASTM D789. The test employs a coulometric Karl Fischer titration technique using a nitrogen-flushed heated chamber to drive moisture into the solution. Commercial equipment is available to carry out this test. Manufacturer's quality control tests normally include tests for contamination, color, moisture, ash, viscosity, packaging (qv), and other properties as appropriate.

In recent years most polyamide suppliers have made data available using a common computer database software known as CAMPUS (Computer Aided Material Preselection by Uniform Standards). All data in this database is measured in common ISO format (ISO 10350 for single point and ISO 11403-1/2 for

RHEOLOGICAL
MEASUREMENTS

Rheology is the science of the deformation and flow of matter. It is concerned with the response of materials to applied stress. That response may be irreversible viscous flow, reversible elastic deformation, or a combination of the two. Control of rheology is essential for the manufacture and handling of numerous materials and products, eg, foods, cosmetics, rubber, plastics, paints, inks, and drilling muds. Before control can be achieved, there must be an understanding of rheology and an ability to measure rheological properties.

Deformation is the relative displacement of points of a body. It can be divided into two types: flow and elasticity. Flow is irreversible deformation; when the stress is removed, the material does not revert to its original form. This means that work is converted to heat. Elasticity is reversible deformation; the deformed body recovers its original shape, and the applied work is largely recoverable. Viscoelastic materials show both flow and elasticity.

This article is concerned with rheological measurements on both liquids and solids and the principles on which they are based. The flow properties of a liquid are defined by its resistance to flow, ie, viscosity, and may be measured by determining the rate of flow through a capillary, the resistance to flow when the fluid is sheared between two surfaces, or the rate of motion of an object or ball moving through the fluid. The mechanical properties of an elastic solid may be studied by applying a stress and measuring the deformation or strain. Many solids, such as polymers, undergo flow in addition to recoverable elastic deformation. Furthermore, a number of liquids show elastic as well as flow behavior. These materials are viscoelastic, and additional techniques beyond those indicated for solids and liquids are needed for complete characterization. Examples of such methods are the measurement of response to sinusoidal oscillatory motion; the measurement of flow with time after application of stress, ie, creep; and the measurement

from viscosities at other temperatures. Likewise, previously measured viscosity–temperature curves for commerical products are often used to ensure meaningful viscosity data for quality assurance even where temperature control is not possilbe.

The Arrhenius equation holds for many solutions and for polymer melts well above their glass-transition temperatures. For polymers closer to their T_g and for concentrated polymer and oligomer solutions, the Williams–Landel–Ferry (WLF) equation (22) works better (23,24). With a proper choice of reference temperature T_s, the ratio of the viscosity to the viscosity at the reference temperature can be expressed as a single universal equation (eq. 8):

$$\log(\eta/\eta_s) = \frac{-8.86(T - T_s)}{101.6 + (T - T_s)} \tag{8}$$

Because T_s is often defined as $T_g + 50$ K, the equation thus becomes

$$\log(\eta/\eta T_g) = \frac{-17.4(T - T_g)}{51.6 + (T - T_g)}$$

In general, the WLF equation holds over the temperature range T_g to $(T_g + 100°C)$.

Dilute Polymer Solutions. The measurement of dilute solution viscosities of polymers is widely used for polymer characterization. Very low concentrations reduce intermolecular interactions and allow measurement of polymer–solvent interactions. These measurements are usually made in capillary viscometers, some of which have provisions for direct dilution of the polymer solution. The key viscosity parameter for polymer characterization is the limiting viscosity number or intrinsic viscosity, $[\eta]$. It is calculated by extrapolation of the viscosity number (reduced viscosity) or the logarithmic viscosity number (inherent viscosity) to zero concentration.

The *viscosity ratio* or *relative viscosity*, η_{rel}, is the ratio of the viscosity of the polymer solution to the viscosity of the pure solvent. In capillary viscometer measurements, the relative viscosity (dimensionless) is the ratio of the flow time for the solution t to the flow time for the solvent t_0 (Table 2). The specific (sp) viscosity (dimensionless) is also defined in Table 2, as is the viscosity number or reduced (red) viscosity, which has the units of cubic meters per kilogram (m³/kg) or deciliters per gram (dL/g). The logarithmic viscosity number or inherent (inh) viscosity likewise has the units m³/kg or dL/g. For η_{red} and η_{inh}, c, the concentration of polymer, is expressed in convenient units, traditionally g/100 cm³ but kg/m³ in SI units. The viscosity number and logarithmic viscosity number vary with concentration, but each can be extrapolated (Fig. 8) to zero concentration to give the limiting viscosity number (intrinsic viscosity) (Table 2). Usually, measurements at four or five concentrations are needed.

The specific viscosity can also be represented by (25)

$$\eta_{sp} = [\eta]c + k_1[\eta]^2 c^3$$

Table 2. Viscosity Expressions

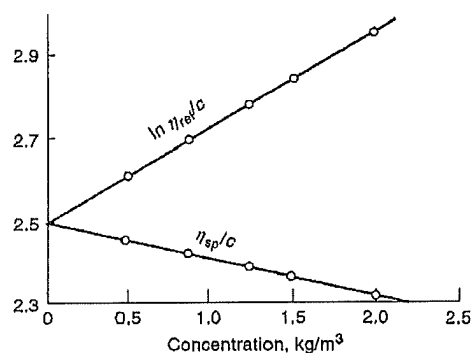| Common name	Recommended name	Definition	Common units
Relative viscosity	Viscosity ratio	$\eta_{rel} = t/t_0 = \eta/\eta_0$	None
Specific viscosity		$\eta_{sp} = (\eta - \eta_0)/\eta_0 = \eta_{rel}^{-1}$	None
Reduced viscosity	Viscosity number	$\eta_{red} = \eta_{sp}/c = \left(\eta_{rel}^{-1}\right)\big/c$	dL/g
Inherent viscosity	Logarithmic viscosity number	$\eta_{inh} = (\ln \eta_{rel})/c$	dL/g
Intrinsic viscosity	Limiting viscosity number	$[\eta] = \lim_{c \to 0} \dfrac{\eta_{rel}}{c} = \lim_{c \to 0} \dfrac{\ln \eta_{rel}}{c}$	dL/g

Fig. 8. Plots of viscosity number ($\eta_{rel} = \eta_{sp}/c$) and the logarithmic viscosity number ($\eta_{inh} = \eta_{rel}/c$) vs concentration. Extrapolations to zero concentration give the limiting viscosity number $[\eta]$.

which becomes the Huggins equation (26)

$$\eta_{sp}/c = [\eta](1 - k_h[\eta]c)$$

where k_h is the Huggins viscosity constant, the most commonly used dilute solution viscosity number or index. It is easily determined from the slope of a plot of η_{sp}/c vs c such as the lower plot in Figure 8. The Huggins constant can be thought of as a measure of the "goodness" of the solvent for the polymer with values around 0.3 in good solvents and 0.5–1 in theta solvents. A large number of Huggins constants can be found in Reference 25 along with constants for another semiempirical equation relating viscosity and concentration, that of Schulz and Blaschke (27).

Adresse http://www.ultc.com/en/methods/rheological/solution_viscosity.php

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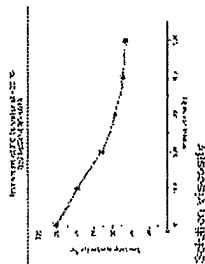- Chemical resistance test methods
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Solution viscosity

Determination of viscosity number of thermoplastics
This method involves measuring the flow times of a polymer in solution as it passes through a Ubbelohde viscometer and then determining the difference between the polymer solution and the solvent.

Taking into account the mass concentration of the polymer solution, the viscosity number can then be calculated.
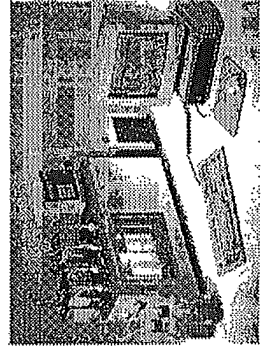
The viscosity number can be correlated with a polymer's molar mass.

The result when polymers are subjected to major stress, during processing for example, is frequently molecular decomposition. This type of effect can be quantified by calculating the viscosity number. Molecular changes due to immersion in media can also be detected via this method (see figure).

Solution viscosity

Standards
DIN 51562
ISO 1628

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